

# **Bacteria TMDL Development for the Banister River Basin**

**Local Steering Committee Meeting # 2**

**Chatham USDA Service Center**

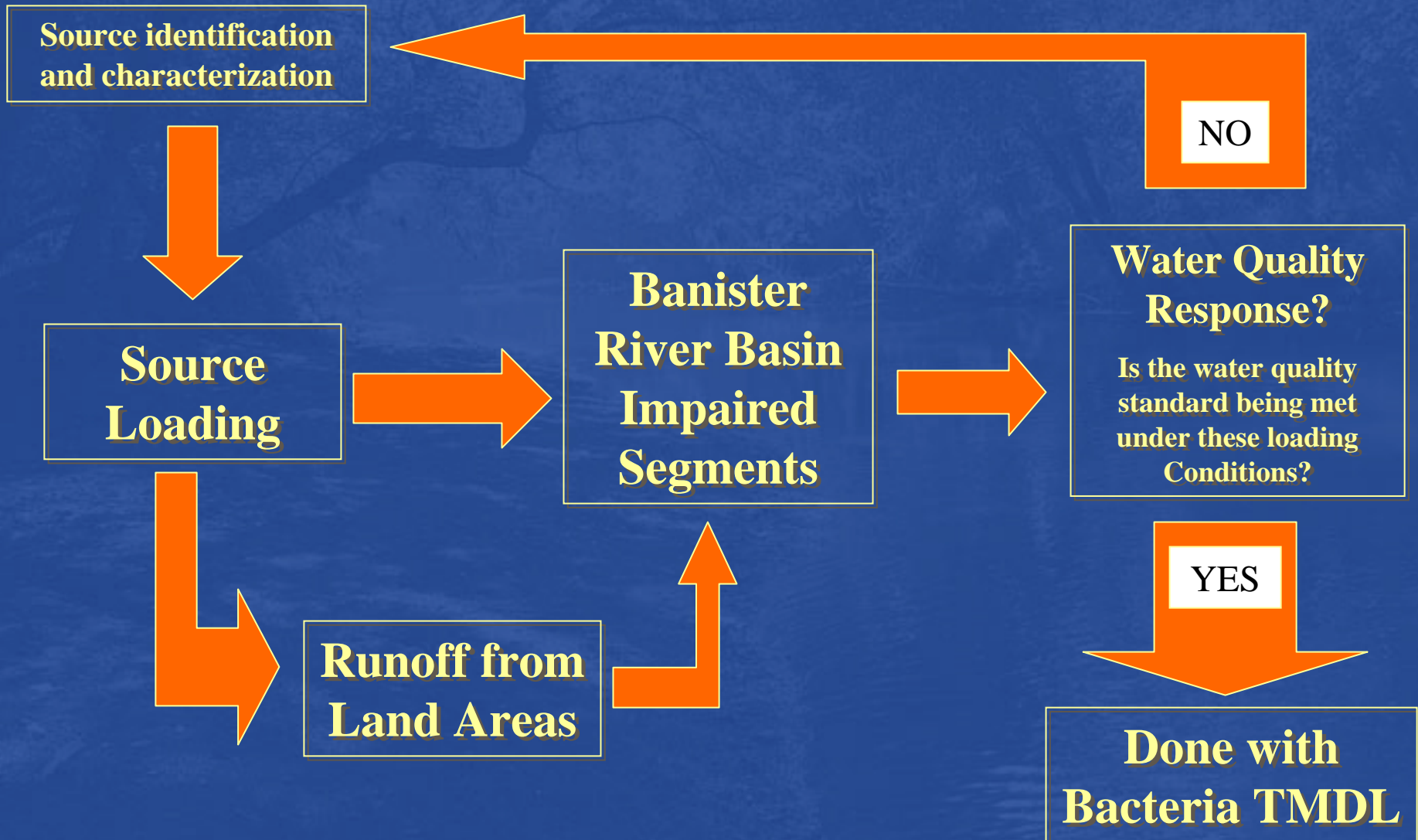
**March 12, 2007**



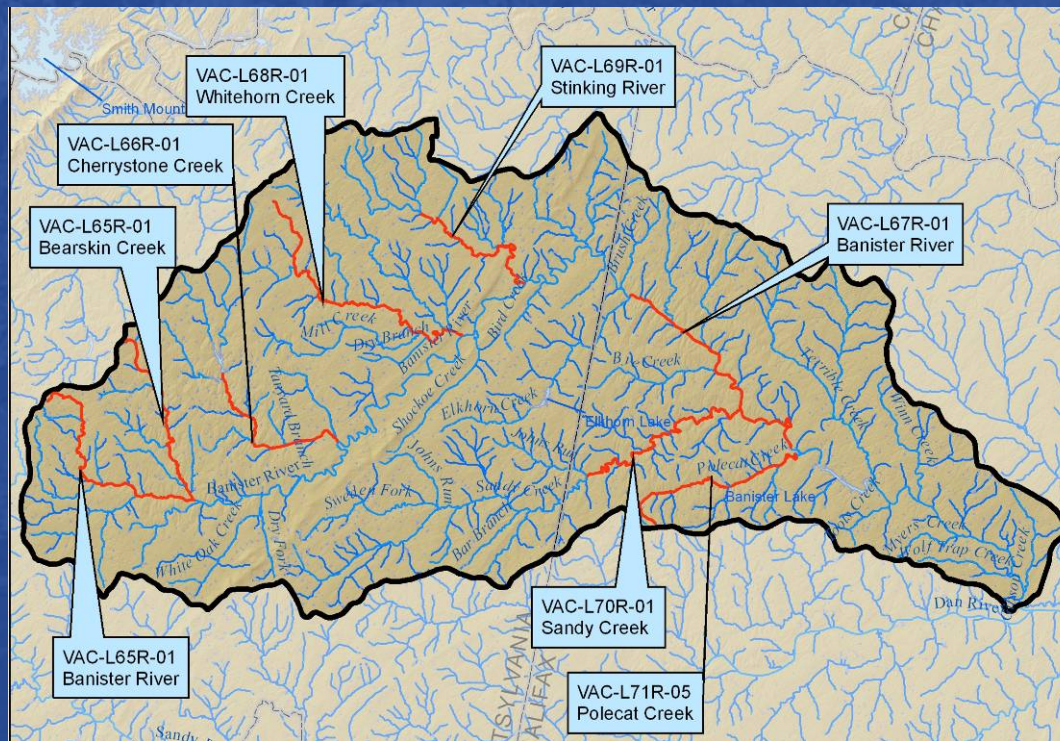
# Recap: Meeting 1

- Discussed what is a TMDL? Why? and how?
- Presented the listed segments of the Banister River Watershed
- Discussed steps used in the TMDL development
- Discussed the data used in the TMDL development
- Presented the TMDL technical approach

# Bacteria TMDL Development



# Bacteria Impairments



TMDL ID	Stream Name	Miles	Impairment for	Violation Rate
VAC-L65R-01	Banister River	11.67	Total Fecal Coliform	2/18
VAC-L67R-01	Banister River	13.18	E. Coli	4/16
VAC-L65R-02	Bearskin Creek	9.31	E. coli	2/7
VAC-L66R-01	Cherrystone Creek	8.44	Total Fecal Coliform	1/8
VAC-L71R-05	Polecat Creek	9.66	Total Fecal Coliform	3/13
VAC-L70R-01	Sandy Creek	11.78	Total Fecal Coliform	3/19
VAC-L69R-01	Stinking River	8.99	Total Fecal Coliform	3/20
VAC-L68R-01	Whitehorn Creek	24.73	E. coli (2006), Total Fecal Coliform (2002)	E. coli - 2/8 Fecal Coliform 1/8

# Bacteria Water Quality Standards

- **Bacteria Impairment:** the Primary Contact Recreation designated use is not met due to exceedances of the water quality criterion for bacteria
- A segment is listed as impaired if more than 10% of samples exceed the criteria
- As of January 15, 2003, *E. coli* is used as the indicator species instead of Fecal Coliform
- Virginia and EPA have agreed on a translator for TMDL model development

# Water Quality Exceedences

## Fecal Coliform Exceedences

Stream Name	Station ID	Count	Date Sampled		Fecal Coliform Values (no/100ml)			Fecal Inst.Exceedences	
			First	Last	Min	Max	Average	Sum	Percent
Banister River	4ABAN023.28	3	7/25/2005	9/26/2005	50	340	203	0	0%
	4ABAN070.20	41	2/13/1995	8/31/2005	100	2500	307	7	17%
Cherrystone Creek	4ACRR003.56	28	3/21/1995	6/5/2001	100	2300	493	11	39%
Polecat Creek	4APEC006.49	13	8/9/2001	6/5/2003	100	1700	446	3	23%
Sandy Creek	4ASNA000.20	21	2/9/2000	9/26/2005	60	1200	237	3	14%
Stinking River	4ASNE005.30	44	2/13/1995	9/26/2005	100	2700	341	8	18%

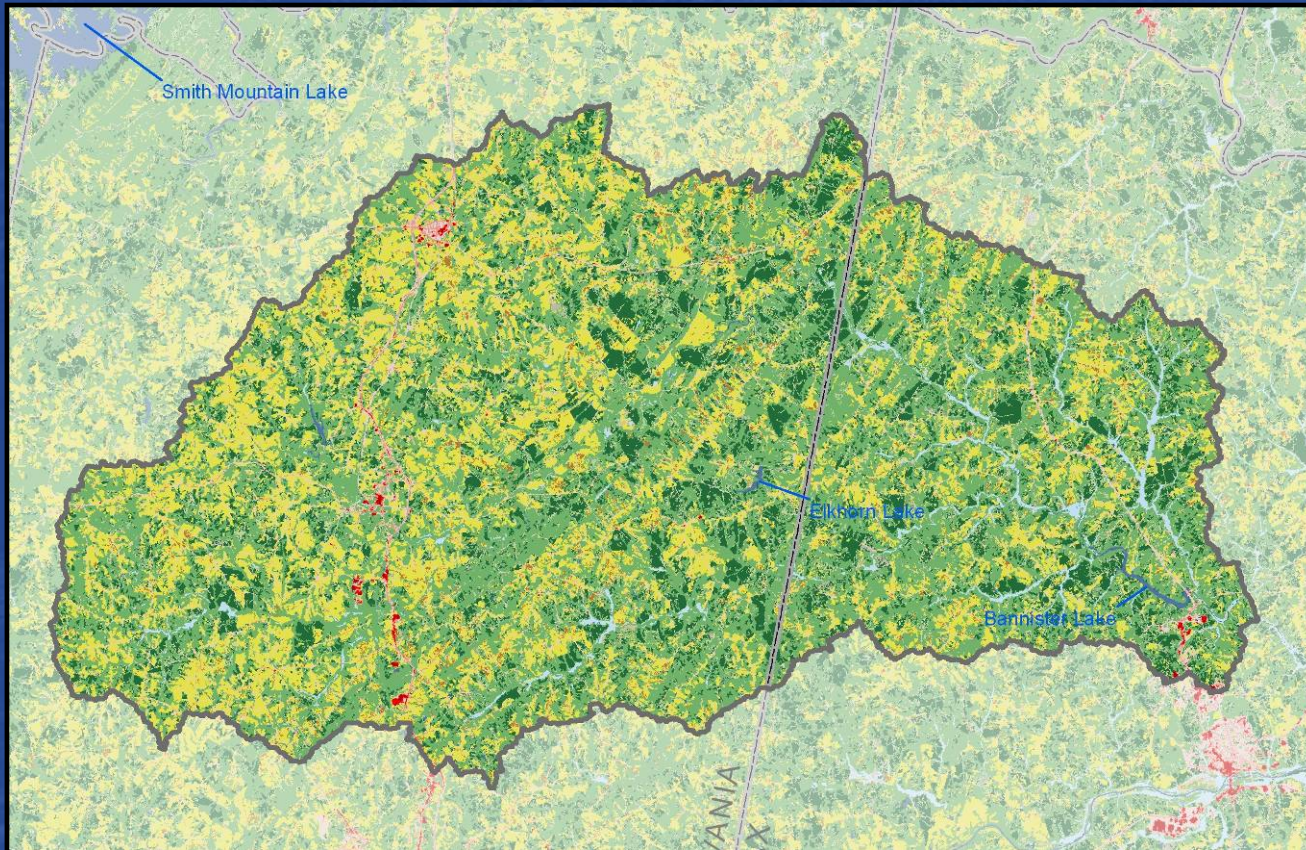
## E. coli Exceedences

Stream Name	Station ID	Count	Date Sampled		E. coli Values			Ecoli Inst.Exceedences	
			First	Last	Min	Max	Average	No.	Percent
Banister River	4ABAN023.28	25	2/9/2000	12/12/2005	10	2000	229	5	20%
	4ABAN070.20	5	7/26/2005	12/13/2005	84	198	127	0	0%
Bearskin Creek	4ABKN000.52	10	11/24/2003	5/10/2005	25	700	164	1	10%
Cherrystone Creek	4ACRR003.56	12	7/30/2003	5/10/2005	25	580	170	2	17%
Sandy Creek	4ASNA000.20	6	7/25/2005	12/12/2005	39	225	80	0	0%
Stinking River	4ASNE005.30	6	7/25/2005	12/12/2005	68	223	158	0	0%
Whitehorn Creek	4AWRN000.43	11	7/30/2003	5/10/2005	25	1400	225	2	18%



# Watershed Characterization

# Banister River Watershed Land Use



**Dominate Land Use  
Types:**

**Forest: 60%**

**Agricultural: 27%**

**Total Acres: 355,319**

# Land Use Distribution

Land Use Category	NLCD Land Use Type	Acres		Percent of Watershed's Land Use Area	
Water/ Wetlands	Open Water	1,272	6,677	0%	2%
	Woody Wetlands	5,362		2%	
	Emergent Herbaceous Wetlands	43		0%	
Urban	Developed, Low Intensity	2,961	3,675	1%	1%
	Developed, Medium Intensity	487		0%	
	Developed, High Intensity	226		0%	
Agriculture	Pasture/Hay	90,558	95,457	26%	27%
	Cultivated Crops	4,899		1%	
Forest	Deciduous Forest	143,095	214,195	40%	60%
	Evergreen Forest	45,710		13%	
	Mixed Forest	12,959		4%	
	Shrub/Scrub	12,431		3%	
Other	Developed, Open Space	17,843	35,316	5%	10%
	Barren Land (Rock/Sand/Clay)	780		0%	
	Grassland/Herbaceous	16,693		5%	
Total		355,319		100%	

Source: NLCD 2001

# Bacteria Sources

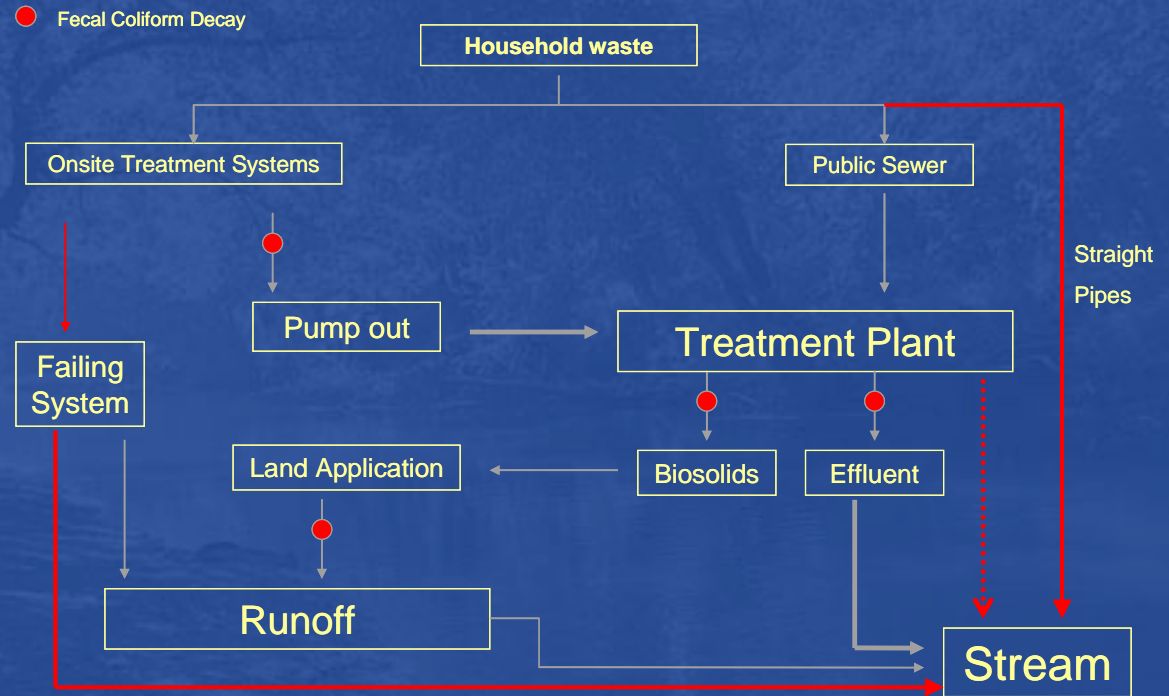
**Address bacteria loading from:**

- Human Sources
- Livestock
- Wildlife
- Pets

# Bacteria Loading from Human Sources

## Inventory and characterize

- Permitted sources
- Septic systems
  - Failure rates
- Straight pipes
- Land application of Biosolids



# Banister River Point Source Inventory

(VA Department of Environmental Quality)

Category	Permit Type	Count (Active or Application)
VPDES	Industrial	2
	Municipal	8
General Permits	Single Family Domestic Sewage	9
	VPA*	9
	Poultry	1
Total		29

\*Permits are issued for animal feeding operations with 300 or more animal units

# Population Estimates and Sewage Disposal

Based on 2000 United States Census Data:

- Population in the watershed is approximately 24,909 people
- There are approximately 10,031 households within the watershed
- Approximately 7,950 households in the watershed are on septic systems
- Assuming a septic system failure rate of 3%, 240 septic systems may be failing.
- Failed septic systems are considered straight pipes if located within 200 feet of a stream and are assumed to be directly discharging sewage into the stream.
  - Estimated Number of failed septics within 200 ft of streams: 25
  - Estimated Number of straight pipes within 200 ft of streams: 19
- Septic system design flow is 75 gal per person per day

# Land Application of Biosolids

Year	Halifax	Pittsylvania
2005	-	2,344
2006	-	2,636

- **Fecal coliform content of biosolids is approximately 2 counts per gram of dry solids, which is less than the fecal coliform in average soil**
- **Biosolids applied to:**
  - Cropland
  - Pasture

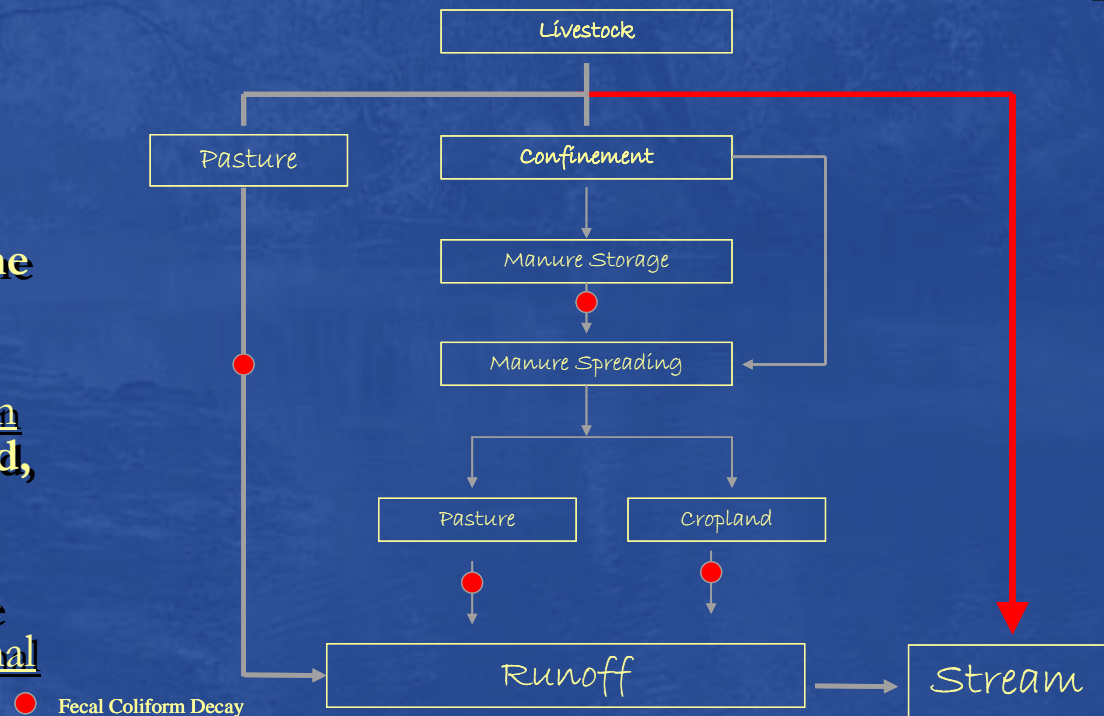
Source: VDH

# Loading from Livestock

Fecal coliform produced by livestock can enter the watershed through four pathways:



1. **Manure deposited on land by grazing livestock is washed off during rainfall events**
2. **Manure directly deposited into the stream by livestock with direct access to the stream**
3. **Manure deposited by livestock in confinement is typically collected, stored and applied to the landscape**
4. **Wash-water and waste from the drainage systems of confined animal facilities**



# Loading from Livestock

Fecal Coliform loading from livestock requires developing:

- Livestock inventory
- Livestock confinement schedules
- Livestock grazing and stream access
- Manure management

# Revised Livestock Estimates

Predominate Livestock Type	Halifax	Pittsylvania	Total
Beef cows	4,811	17,206	22,018
Milk cows (total)	0	4,100	4,100
Hogs and pigs inventory	2,758	1,544	4,301
Sheep and lambs inventory	23	118	141
Chickens	20,000	15,300	35,300
Horses and ponies, inventory	402	2,500	2,902

These estimates were revised based on data provided by the local steering committee and Halifax and Pittsylvania SWCDs

# Cows - Daily Schedule

## Beef Cow

Month	Time Spent in		
	Pasture	Stream	Loafing Lot
	(Hour)	(Hour)	(Hour)
January	23.50	0.50	0
February	23.50	0.50	0
March	23.25	0.75	0
April	23.00	1.00	0
May	23.00	1.00	0
June	22.75	1.25	0
July	22.75	1.25	0
August	22.75	1.25	0
September	23.00	1.00	0
October	23.25	0.75	0
November	23.25	0.75	0
December	23.50	0.50	0
Source: Dodd Creek TMDL Report, DCR 2002, Falling River Report TMDL Report (2004)			

## Dairy Cow

Month	Time Spent in		
	Pasture	Stream	Loafing Lot
	(Hour)	(Hour)	(Hour)
January	7.45	0.25	16.30
February	7.45	0.25	16.30
March	8.10	0.50	15.40
April	9.35	0.75	13.90
May	10.05	0.75	13.20
June	10.30	1.00	12.70
July	10.80	1.00	12.20
August	10.80	1.00	12.20
September	11.05	0.75	12.20
October	11.00	0.50	12.50
November	10.30	0.50	13.20
December	9.15	0.25	14.60
Source: Dodd Creek TMDL Report, DCR 2002, Falling River Report TMDL Report (2004)			

# Manure Management

- **Typical application areas**
  - Cropland
  - Pastureland
- **Typical application rates**
  - Liquid: 3,000 gallons per acre
  - Solid: 10 tons per acre

# Wildlife Inventory

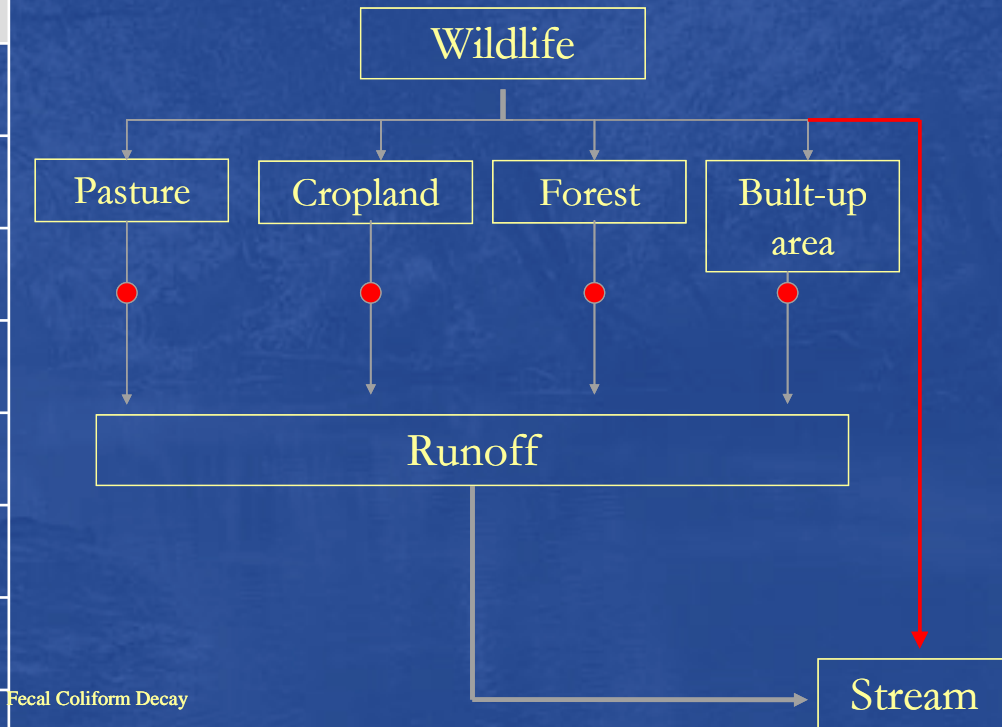


Wildlife type	Population Density	Habitat Requirements
Deer	0.047 animals/acre	Entire Watershed
Raccoon	0.07 animals/acre	Within 600 feet of streams and ponds
Muskrat	2.75 animals/acre	Within 66 feet of streams and ponds
Beaver	4.8 animals/mile of stream	
Goose	0.02 animals/acre	Entire Watershed
Mallard	0.002 animals/acre	Entire Watershed
Wood Duck	0.0018 animals/acre	Within 66 feet of streams and ponds
Wild Turkey	0.01 animals/acre	Entire watershed excluding farmsteads and urban land uses
Source: Map Tech, Inc., 2001, Goose Creek TMDL		



# Revised Wildlife Estimates

Wildlife Animal	Halifax	Pittsylvania	Total
Deer	5,114	11,586	16,700
Raccoon	4,773	10,058	14,831
Muskrat	20,627	43,466	64,093
Beaver	2,250	4,742	6,992
Goose	1,072	2,428	3,500
Mallard	161	339	500
Wood duck	161	339	500
Wild Turkey	832	1,601	2,433



These estimates were revised based on data provided by the TAC committee and Halifax and Pittsylvania SWCDs

# Revised Pet Estimates

## Pet inventories based on:

- Cats: 0.598 per household American Veterinary Medical Association (AVMA) estimates
- Dogs: Halifax and Pittsylvania Animal Control Centers

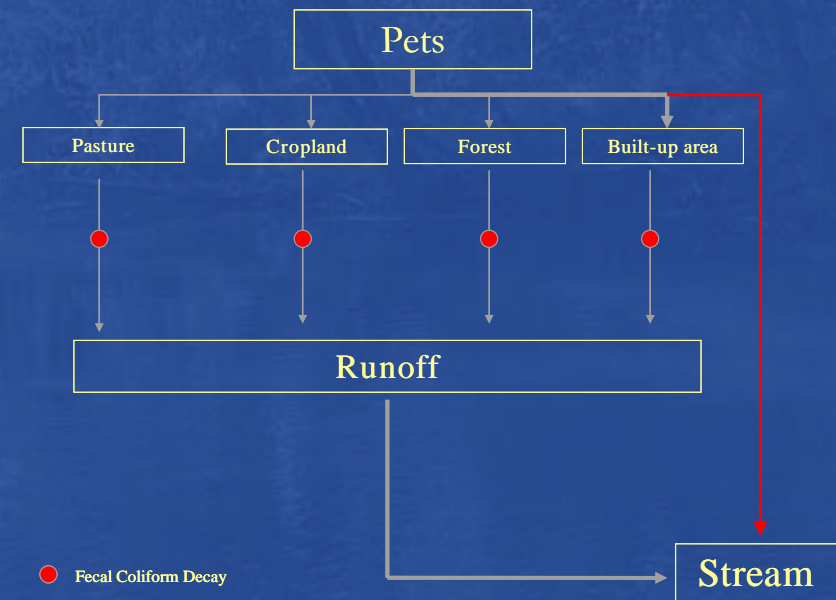
In the Banister River Watershed there are approximately:

County	Halifax	Pittsylvania	Total
Cats	1,720	4,229	5,948
Dogs	4,000	6,000	10,000

The load estimated by daily fecal coliform production rates:

4.09 x10<sup>9</sup> cfu/day per animal for dogs.

504 cfu/day per animal for cats



# Source Loading Estimates

# Source Loading Estimates

- Determine the daily fecal coliform production by source
- Estimate the size/number of each source
- Determine whether the source is
  - Direct Source
  - Indirect Source
- Calculate the load to each land use based on a monthly schedule and for each source
- The sum of all the individual sources is the total load

# Daily Fecal Coliform Production by Source

Source	Fecal Coliform Content in Fecal Matter (million) (cfu/day)
Human	1,950
Pet	450
Horse	420
Beef Cattle	33,000
Dairy-Milked or dry Cow	25,200
Dairy-Heifer	11,592
Sheep	27,000
Deer	347
Raccoon	113
Muskrat	25
Beaver	0.2
Goose	799
Duck	2,430
Mallard	2,430
Wild Turkey	93
Hog	10,800
Chicken (Layer)	136

Source	The Equivalent Number of Sources to One Beef Cow
Human	16.92
Pet	73.33
Horse	78.57
Beef Cattle	1.00
Dairy-Milked or dry Cow	1.31
Dairy-Heifer	2.85
Sheep	1.22
Deer	95.10
Raccoon	292.04
Muskrat	1,320.00
Beaver	165,000.00
Goose	41.30
Duck	13.58
Mallard	13.58
Wild Turkey	354.84
Hog	3.06
Chicken (Layer)	242.65

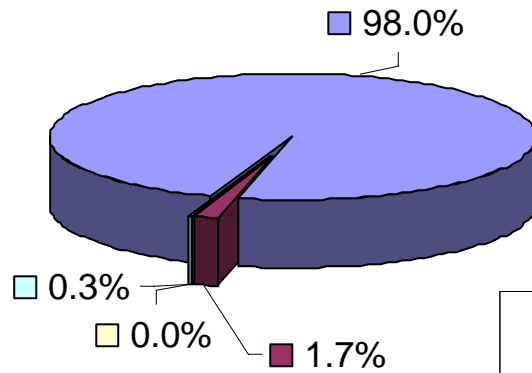
**NOTE:** The fecal coliform content is based on analysis of the fecal matter from these sources.

Sources: ASAE, Map Tech, Metcalf & Eddy,

Source	Number	cfu/an day	cfu/day	% of Time for the Month of June					
				Pasture	Cropland	Stream	Confined	Forest	Urban
Beef Cattle	22,018	3.30E+10	7.27E+14	0.90		0.10	0.00	0.00	
Milk Dairy	2,050	2.52E+10	5.17E+13	0.39		0.08	0.53	0.00	
other diary	2,050	1.16E+10	2.38E+13	0.39		0.08	0.53	0.00	
Horses	2,902	4.20E+08	1.22E+12	0.90		0.10	0.00	0.00	
Sheep	141	2.70E+10	3.80E+12	0.90		0.10	0.00	0.00	
Hog	4,301	1.08E+10	4.65E+13	1.00		0.00	0.00	0.00	
Chicken/layers	35,300	1.36E+08	4.80E+12	0.00		0.00	1.00	0.00	
Total			8.58E+14						
Deer	16,700	3.47E+08	5.79E+12	0.1	0.1	0.05		0.75	
Raccoon	14,831	1.13E+08	1.68E+12					0.95	
Muskrat	64,093	2.50E+07	1.60E+12	0.125	0.125	0.5	0.125	0.125	
Beaver	6,992	2.00E+05	1.40E+09	0		0.9	0	0.1	
Goose	3,500	7.99E+08	2.80E+12	0.1	0.1	0.8			
Mallard	500	2.43E+09	1.22E+12	0.1	0.1	0.8			
Wood Duck	500	2.43E+09	1.22E+12	0.1	0.1	0.8			
Wild Turkey	2,433	9.30E+07	2.26E+11		0.1			0.9	
Total			1.45E+13						
Failed Septic	25	1.00E+04	2.13E+07			1			
Straight pipe	19	1.00E+09	5.61E+10			1			
Total			5.61E+10						
Pet-cat	5,948	4.50E+08	2.68E+12						1
Pet-dog	10,000	1.94E+07	1.94E+12						1
Total			4.62E+12						

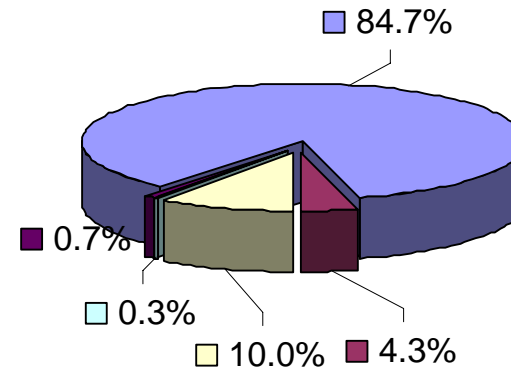
## Fecal Coliform Total Available Daily Loading by Source

■ Livestock ■ Wildlife ■ Human ■ Pets



## Fecal Coliform Total Available Daily Loading by Land Use

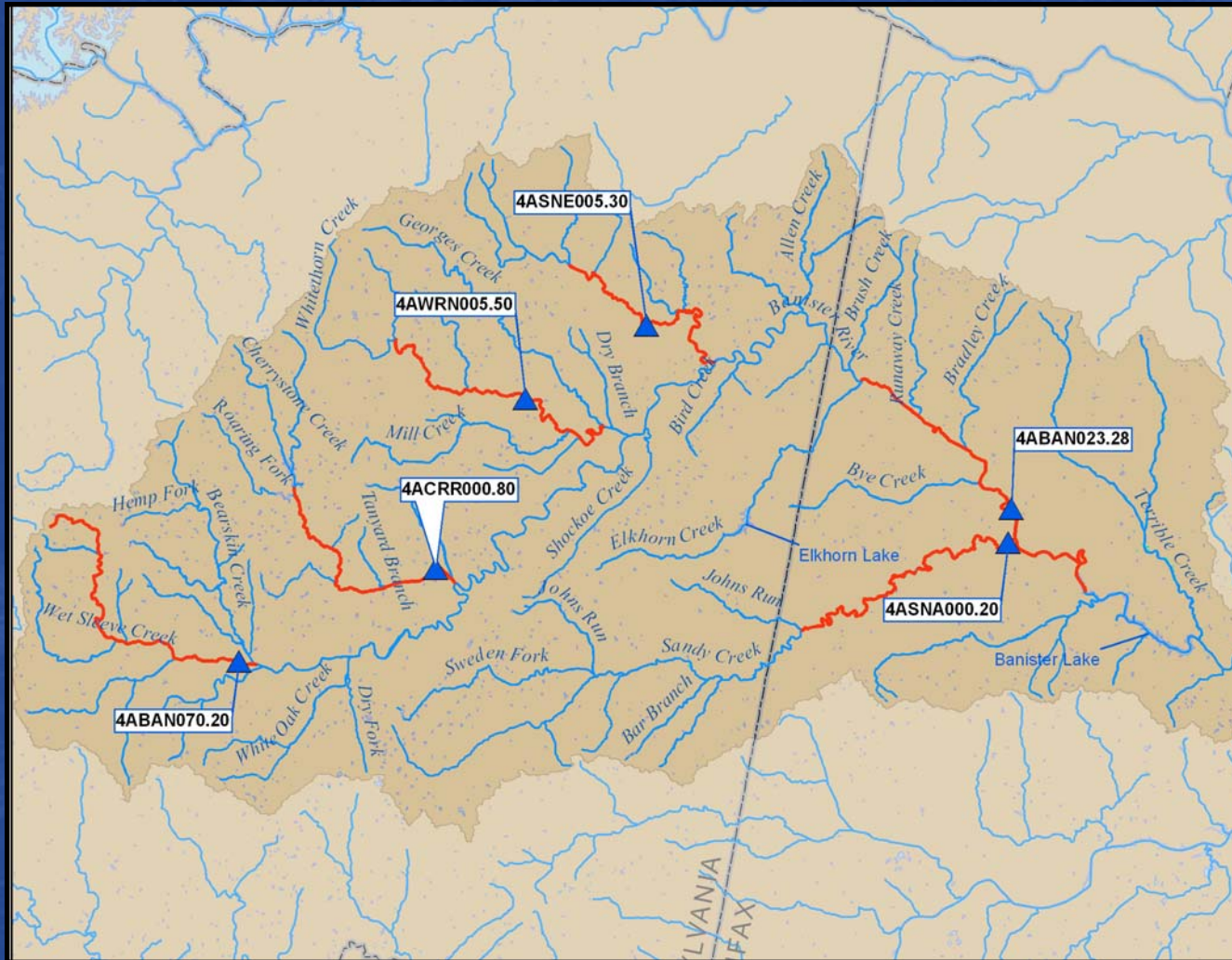
■ Pasture ■ CropInd ■ Direct In Stream ■ Urban ■ Forest



# Bacteria Source Tracking (BST)

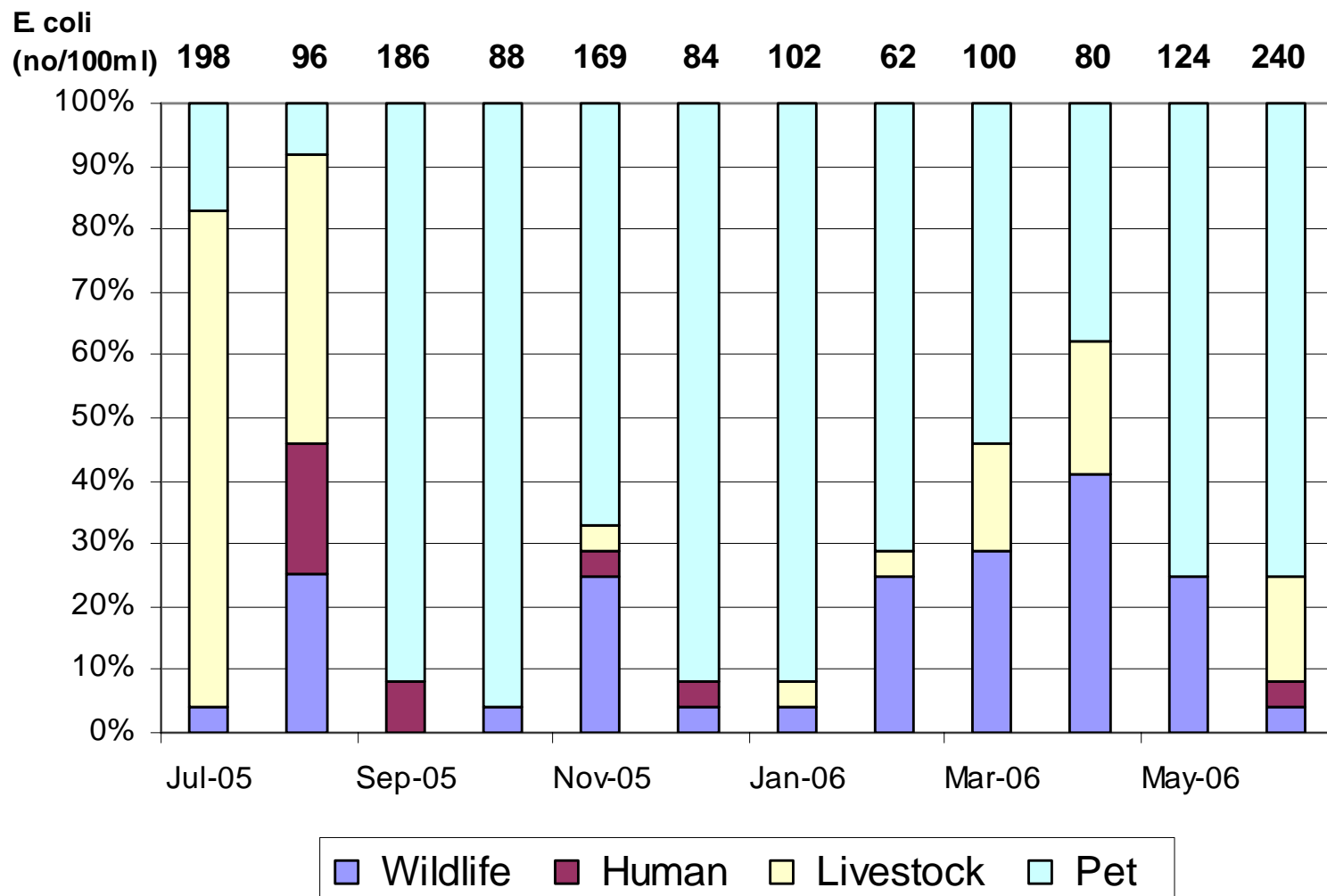
- **BST was conducted monthly at 6 stations**
  - 2 stations on the Banister River
  - 1 station on Cherrystone Creek
  - 1 station on Sandy Creek
  - 1 station on Whitehorn Creek
  - 1 station on the Stinking River
- **A total of 12 sampling events were collected at each station**
- **Results indicate that bacteria from human, livestock, wildlife, and pet sources is present in the watershed**

# BST Sampling Stations



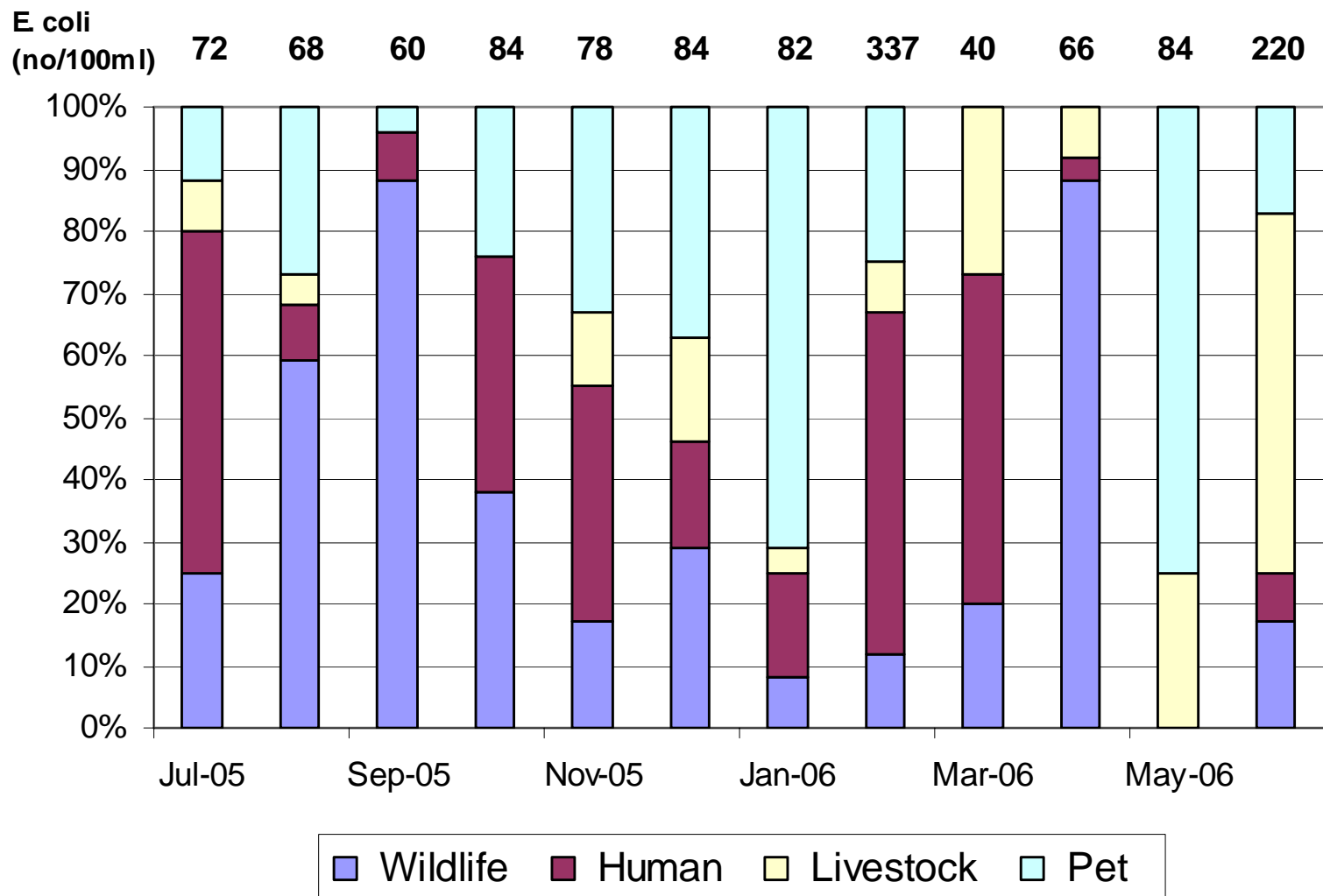
# Banister River Station 4ABAN070.20

## BST Distribution



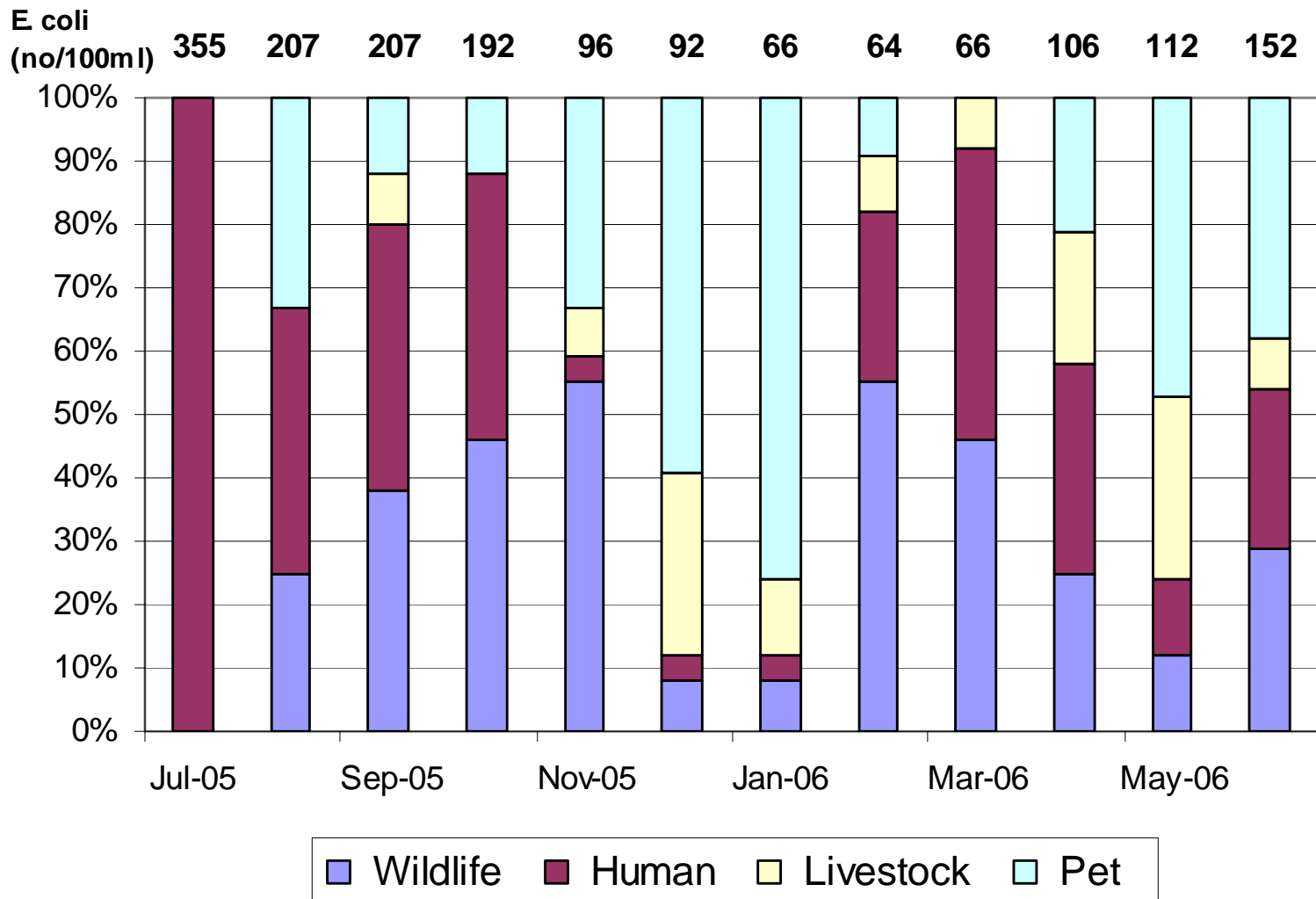
# Banister River Station 4ABAN023.28

## BST Distribution



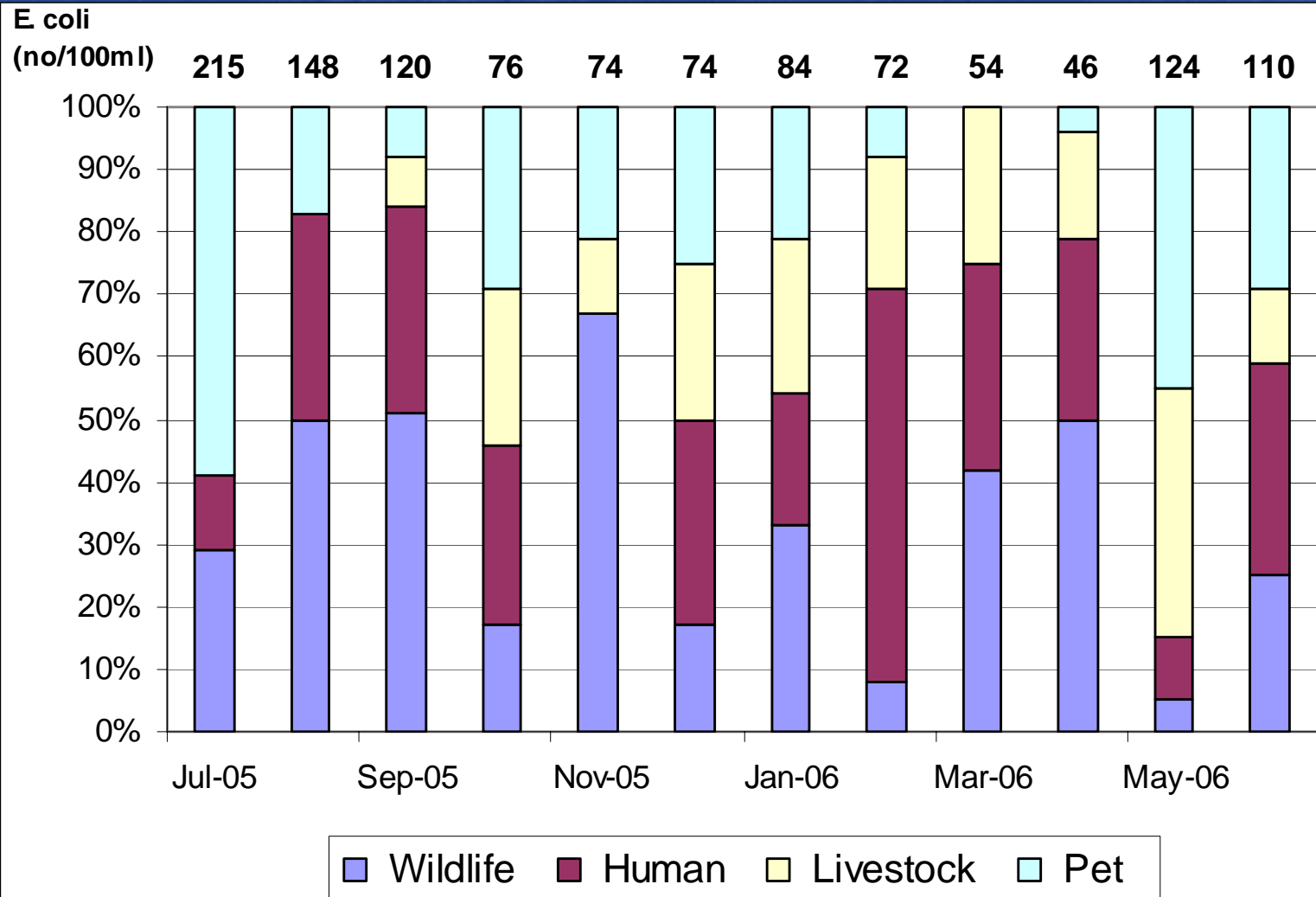
# Cherrystone Creek Station

## 4ACRR000.80 BST Distribution



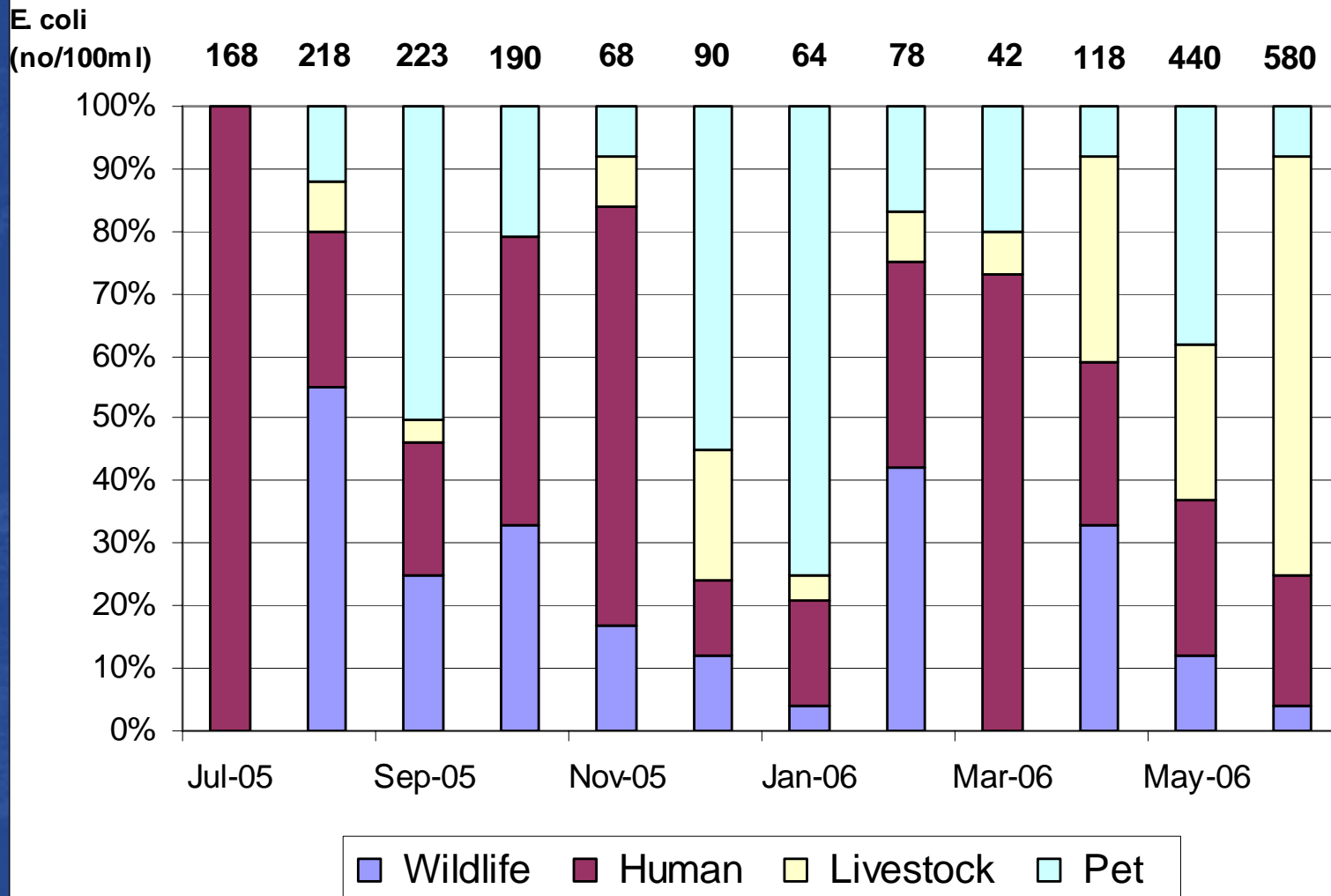
# Whitehorn Creek Station

## 4AWRN005.50 BST Distribution



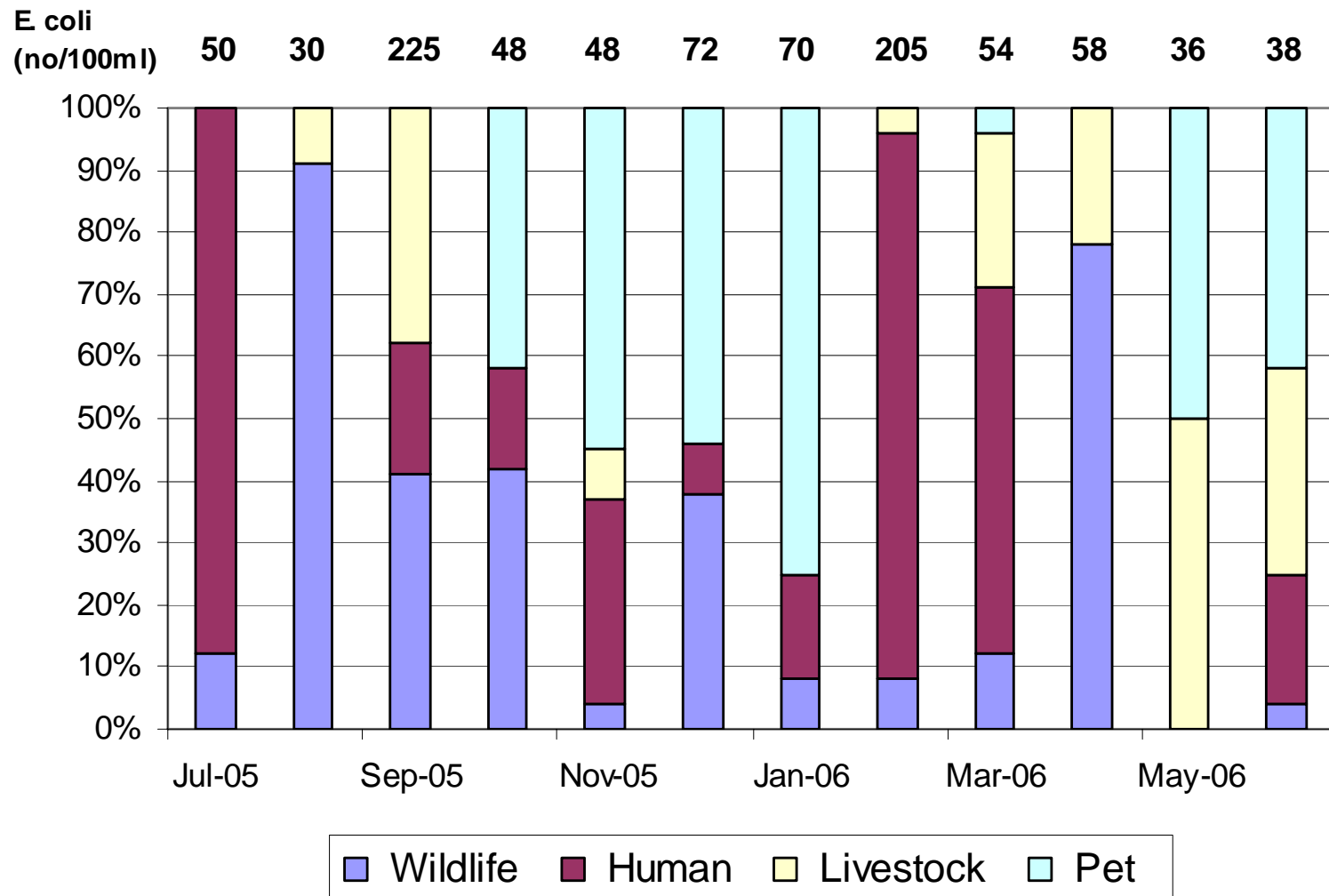
# Sandy Creek Station 4ASNE005.30

## BST Distribution



# Stinking River Station 4ASNA000.20

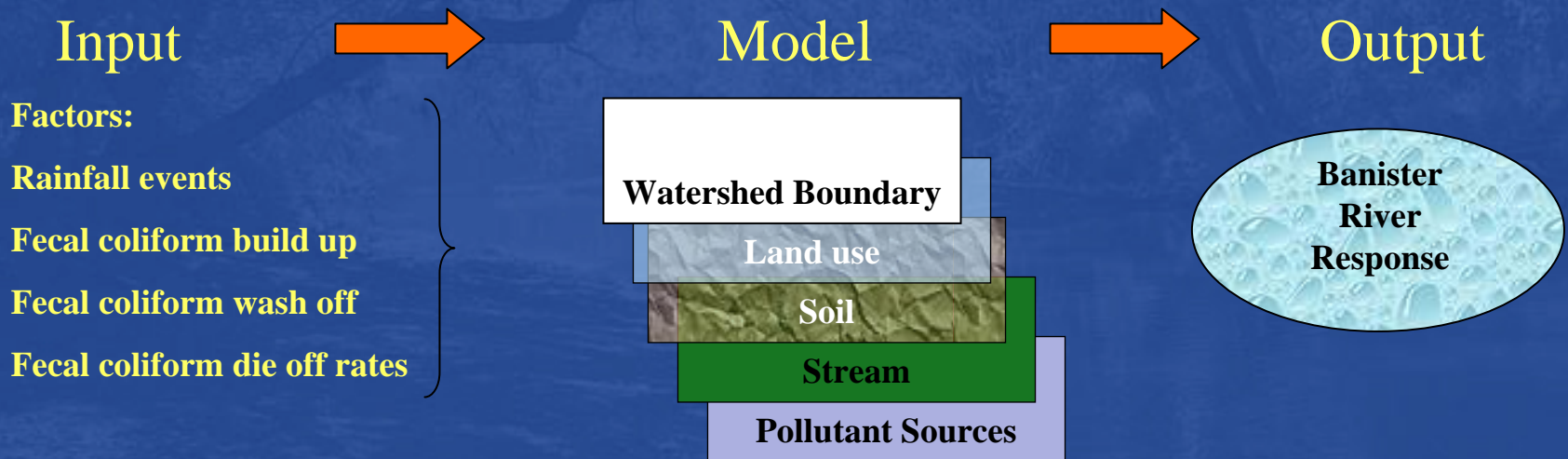
## BST Distribution



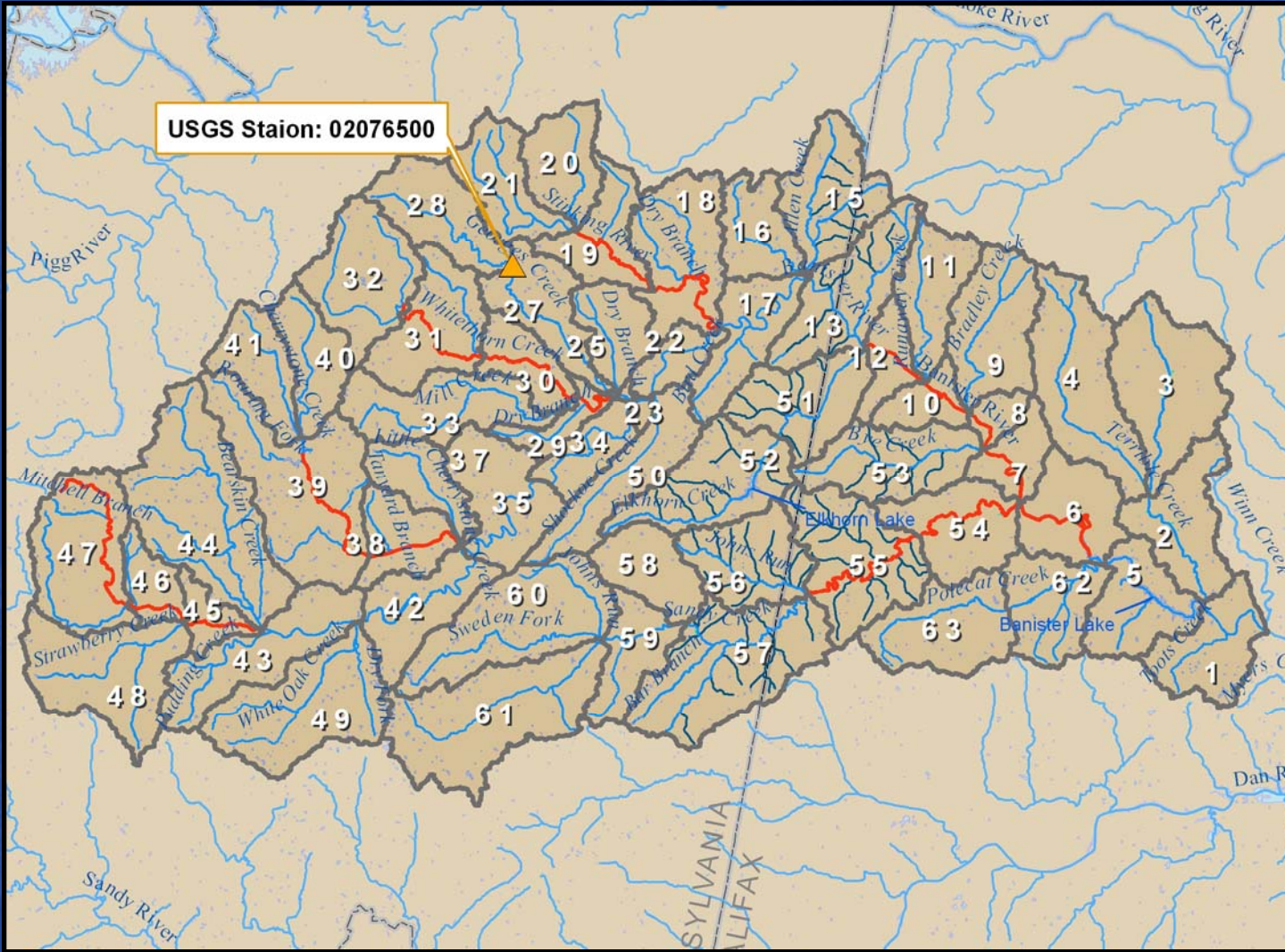
# HSPF Model

# HSPF Model

*Linking Sources to Water Quality*



# HSPF Model Setup Model Segmentation and USGS Flow Station



# HSPF Model Setup

- **Hydrologic Model:**

- USGS Flow Station 02076500: 1949-1997**

- Calibration period: 1992- 1993
- Validation period: 1994-1995

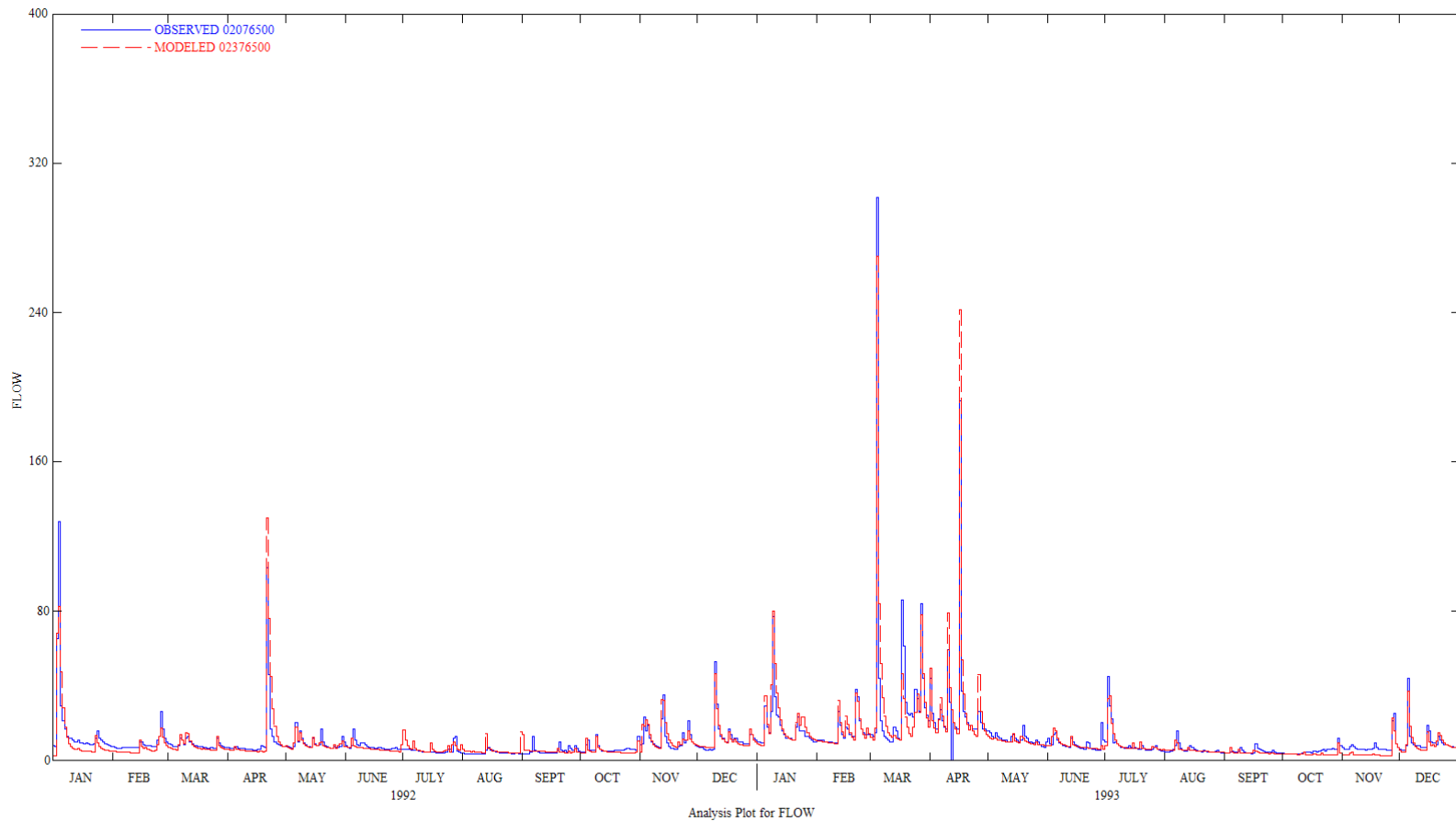
- **Water quality Model:**

- Calibration period: 1999-2000 (Sandy, Cherrystone)
- Validation period : 1999-2000 (Polecat, Stinking)
- TMDL Calculation: 1998-2005

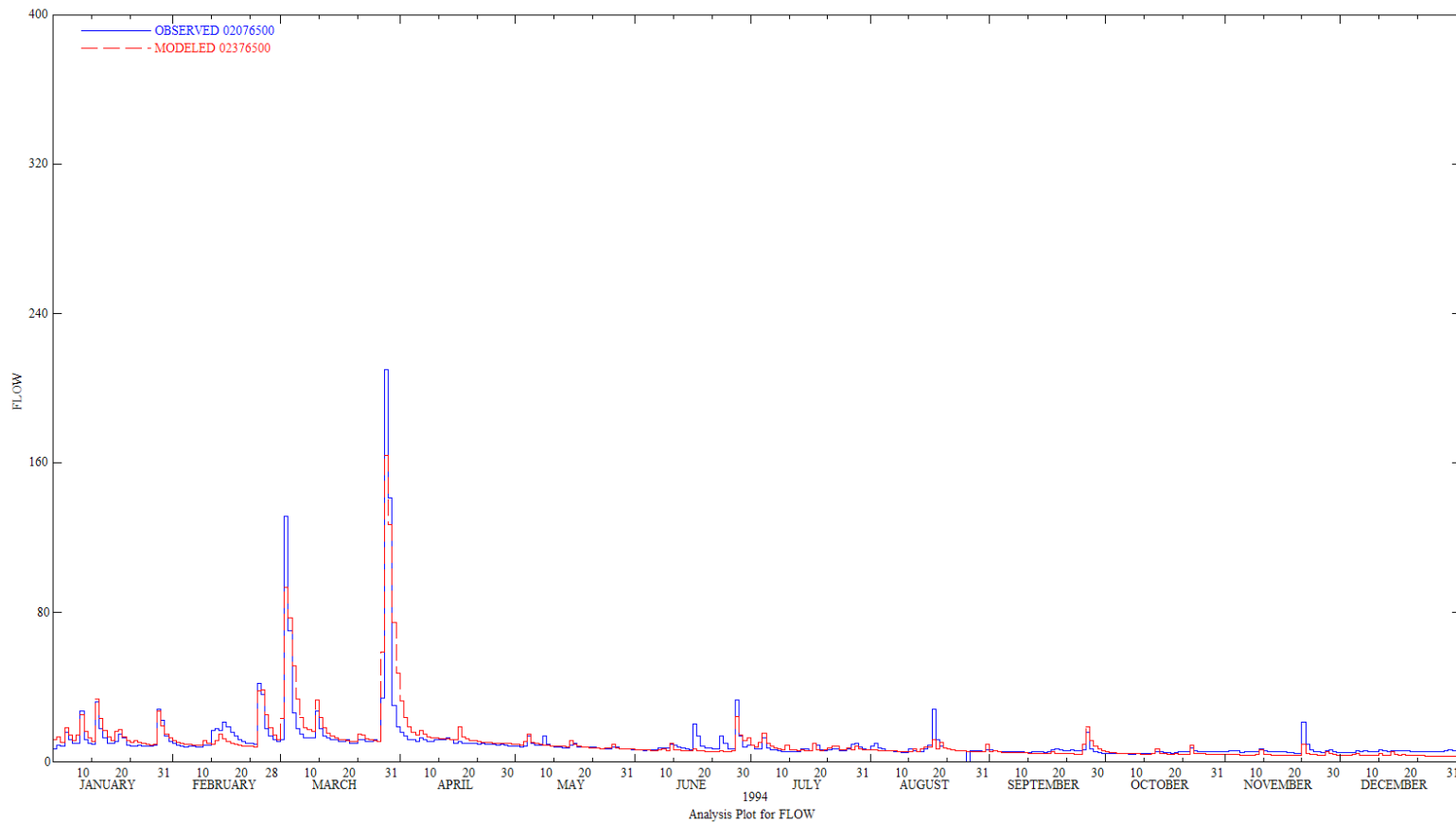
- **Weather data:**

Chatham, VA	1. Jan 1992-Sept 1995
	2. Jan 1998-Sept 2002
Lynchburg, VA Airport	1. Oct 1995-Dec 1997
	2. Oct 2002-Dec 2005

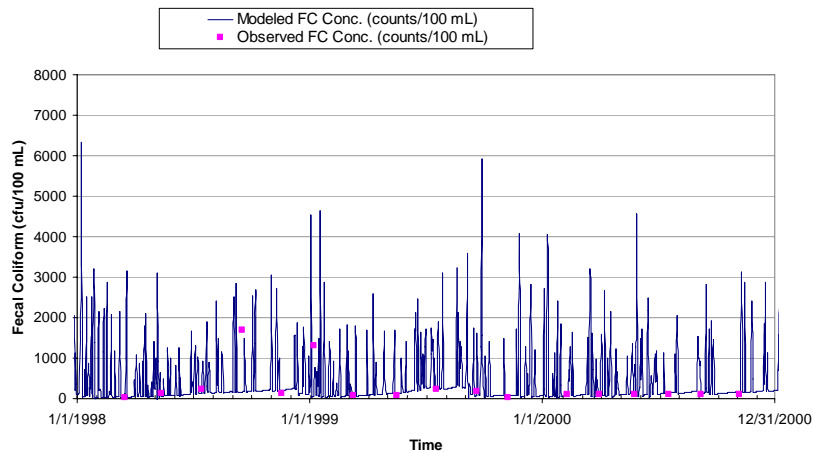
# Hydrology Calibration Results



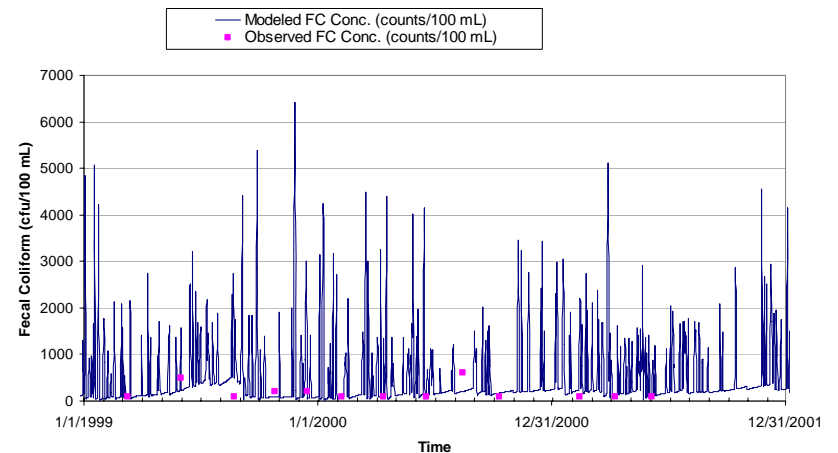
# Hydrology Validation Results



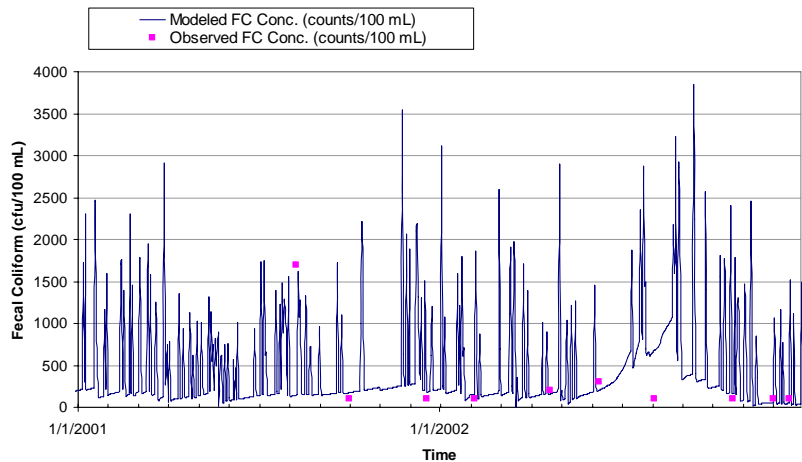
## Sandy Creek



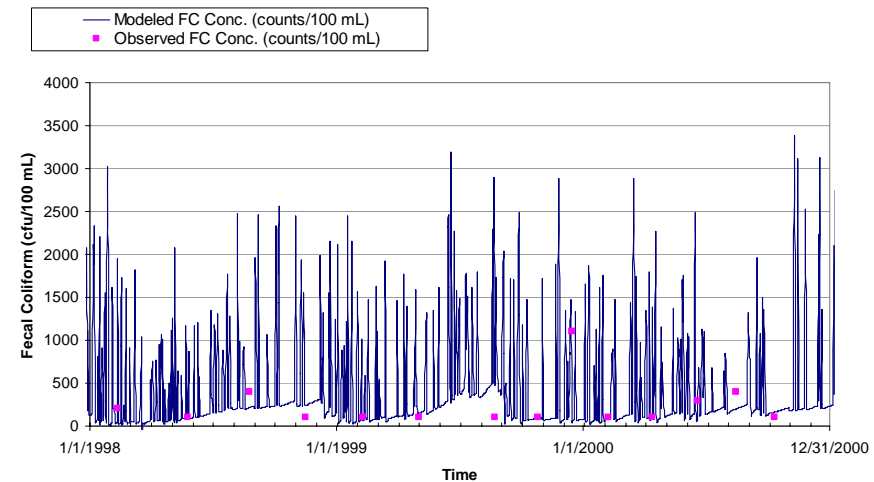
## Cherrystone Creek



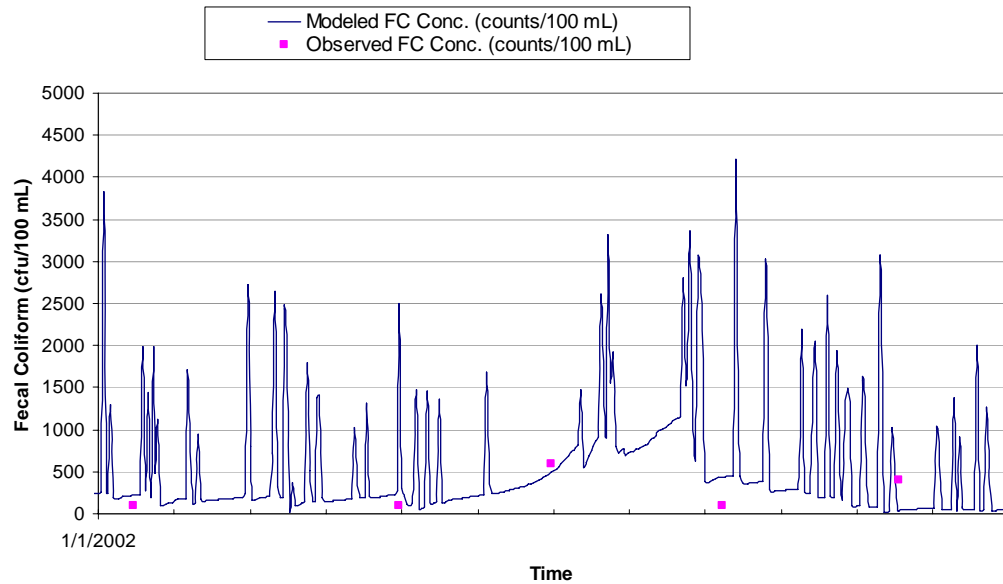
## Polecat Creek



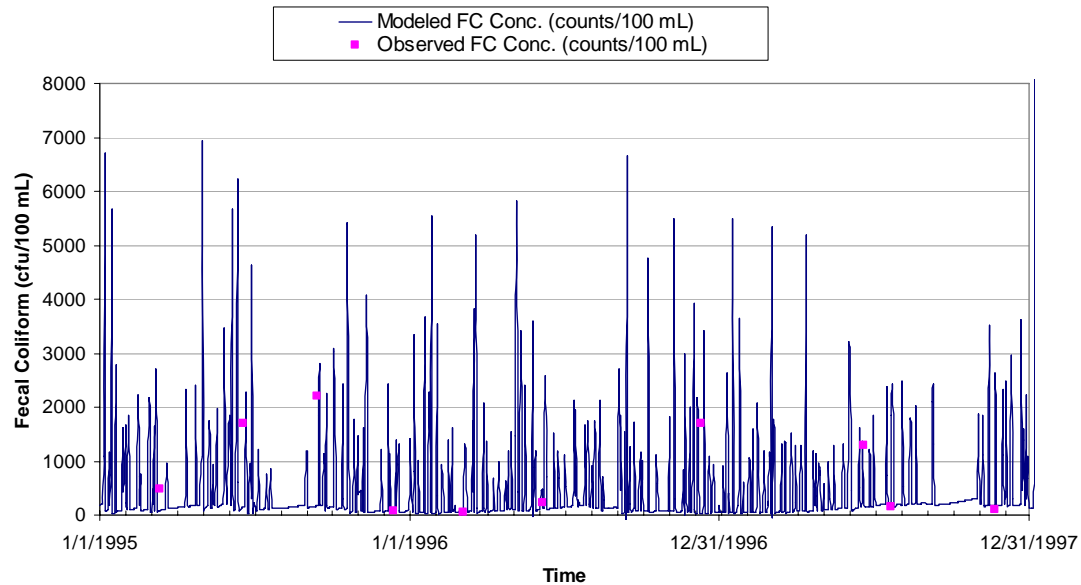
## Stinking River



## River Banister -4ABAN023.28



## River Banister -4ASNE005.30



# Water Quality Calibration Summary

Reach	Water Quality Station	Watershed	Fecal Coliform Geometric Mean (cfu/100ml)		Fecal Coliform Instantaneous Rate of Exceedance (%)	
			Observed	Simulated	Observed	Simulated
7	4ABAN023.28	Banister River	353	214	31%	26%
19	4ASNE005.30	Stinking River	187	199	18%	24%
39	4ACRR003.56	Cherrystone Cr	277	211	39%	24%
45	4ABAN023.28	Banister River	163	191	17%	23%
63	4APEC006.49	Polecat Creek	201	160	23%	22%
54	4ASNA000.20	Sandy Creek	244	177	24%	23%